

Introductory Notes

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Scope

The objective of these introductory notes is to give a brief overview of the present status of cocoa planting materials and breeding methods. This should help to set the context in which any new technologies would need to be applied and may therefore help in the process of formulating recommendations during this workshop. The opinions expressed here are only meant to be a basis for further consideration; they are the sole responsibility of the author of these notes and neither express the opinion of INGENIC as an association nor that of any sponsoring institution of INGENIC.

New technologies used in plant breeding are presently undergoing dramatic development. These technologies can provide new insight into the genetic structure of germplasm and inheritance of selection traits. Thus, they can offer the breeder guidance when deciding on the choice of new parents to be used in breeding and of selection methods. These technologies also have the potential to increase selection efficiency, through marker-assisted selection, and to overcome, through genetic transformation, major production constraints such as losses due to pests and diseases, which are difficult to overcome by traditional methods.

Improvement of cocoa planting material involves several steps: germplasm management, characterisation and evaluation, development of breeding tools (early screening methods, biotechnologies), genetic studies, creation and selection of new varieties (variety trials), and multiplication and distribution of new planting materials. The adoption of new technologies in cocoa breeding will depend not only on the efficiency of these methods (accuracy, costs) in relation to alternative methods, but also on the feasibility of introducing these technologies into practical breeding programmes. There is no doubt that the first requirement for integration of any new technologies is the existence of strong traditional breeding programmes.

Cocoa planting material

The availability of good varieties is a basic feature of sustainable production of any crop. However, it has been estimated that only about 30% of the total cultivated cocoa acreage is planted with selected varieties (Paulin and Eskes 1995). These varieties consist mostly of mixtures of bi-parental crosses (hybrids) between local and introduced clones. Only a very small part is made up of selected clones. The unselected cultivated cocoa varieties consist mostly of traditional populations (Trinitario, Amelonado, F3 Amazon) and of open-pollinated populations derived from selected hybrid varieties. Farmers are increasingly using seeds taken from their own preferred trees. The latter process is expected to result in partial inbreeding of planting materials, known to be related in cocoa to loss of vigour and yielding capacity (INGENIC 1995). This situation demonstrates the urgent need to develop and distribute better varieties.

Diseases and pests continue to cause heavy crop losses in all producing regions, endangering the sustainability of cocoa growing. For example, black pod disease due to *Phytophthora megakarya* causes losses of up to 70% in Central Africa and now

threatens Côte d'Ivoire, which provides 40% of the world's production. The witches' broom disease has reduced cocoa production by 70% in the State of Bahia, Brazil.

Some high yielding clonal cocoa varieties with effective resistance to diseases have been selected during the last 25 years. Examples are the VSD resistant clones selected in Asia (e.g. PBC 123 occupying 30% of the Malaysian cocoa belt) and witches' broom and black pod resistant clones in Trinidad (TSH clones). The latter clones are also being used to control the very serious witches' broom outbreak in Bahia, Brazil. These examples indicate the potential for genetic control of destructive cocoa diseases.

Trends in cocoa breeding

Trends identified in cocoa breeding methods (INGENIC 1995; INGENIC 1999) are:

- Growing interest in clone selection as a method that can give quick genetic progress (resistance, quality,...).
- Initiation or reinforcement of recurrent selection programmes, aiming at continuous genetic progress through adequate use of general and specific combining abilities.
- Initiation or reinforcement of germplasm enhancement programmes, aiming at accumulation of favourable alleles in breeding populations.
- Increased international collaboration, not only for germplasm conservation and distribution but also for germplasm evaluation and utilisation.

Trends in the selection criteria applied in cocoa breeding are:

- More attention is being given to disease and pest resistance, especially in those cases where suitable screening methods are available.
- In addition to breeding for yield, breeders are selecting for more efficient and smaller trees that can be easily managed by the farmers.
- Quality is becoming a major selection criterion for niche markets. The recent evidence of the strong genetic component of flavour traits should make it possible to select more efficiently for these traits.

Recently, efficient, early and rapid screening tests for resistance to *Phytophthora* pod rot have been developed, and these are now becoming widely applied in cocoa germplasm enhancement (Iwaro and Butler, in press) and in cocoa breeding (Eskes, in press). However, methods for early screening for resistance to other important pathogens (like Moniliasis, witches' broom, and VSD) and to insects (mirids and cocoa pod borer) must still be developed or improved.

The above trends indicate that cocoa breeding needs to be based on effective integration of different disciplines using a *teamwork* approach. The role of new technologies in this complex of activities remains to be defined.

Conclusions from the first and second INGENIC Workshops

Before starting this Workshop, it may be useful to remind participants of the conclusions related to New Technologies formulated during the first two INGENIC workshops.

The 1994 Workshop on 'Cocoa Breeding Strategies' (INGENIC 1995) concluded that new technologies:

- are to be considered as 'tools to complement conventional breeding',
- give 'insight into the genetic structure of cocoa populations',
- are 'powerful for characterisation and identification',
- 'should not detract from conventional breeding', and
- 'should be applied to problems that are difficult to solve otherwise'.

The 1996 Workshop on the 'Contribution of Disease Resistance to Cocoa Variety Improvement' (INGENIC 1999) concluded that:

- 'reliable methods are required for disease resistance measurements',
- 'links of markers with black pod resistance have been established',
- 'improved methods of vegetative propagation have a role to play in rapid distribution of clones with resistance to destructive diseases', and
- 'international collaboration is essential to facilitate accumulation of resistance genes'

Cocoa breeders and biotechnologists

For the sake of comparison, cocoa geneticists have been classified into two categories: 'conventional breeders' and 'biotechnologists'. For several reasons, the number of conventional cocoa breeders has been decreasing over the last ten years,, and this appears to endanger the maintenance of strong breeding programmes. Conversely, the number of biotechnologists has been rapidly increasing. A rough estimate of the number of researchers in these two categories indicates that presently approximately 21 active 'conventional breeders' and at least 17 'biotechnologists' are effectively working on cocoa.

The majority of the cocoa biotechnologists are working in laboratories in the Americas and in Europe, suggesting the existence of at least a temporary geographical gap between places of development and places of application of these new technologies. This leads to the question of how and when these technologies could be transferred to user sites.

Workshop Objectives

In preparing for this Workshop, INGENIC has identified the following objectives:

- Analysis of general progress obtained and constraints identified in using new technologies in plant breeding (lead speaker).
- Analysis of progress obtained in the development of new technologies in cocoa.
- Presentation of summarised results that are of direct use to the breeders.
- Presentation and discussion of collaborative new activities.
- Identification of research gaps.
- Formulation of conclusions and recommendations.

The presentations have been grouped into themes Sessions to facilitate discussions on common applications and/or techniques. It is fully appreciated that there will be some overlap between the contents of the Sessions, but it is hoped that this will not adversely affect our discussions.

References

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